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Development of Technology for Processing Oil Sludge with Application of Super High Frequency Electromagnetic Fields

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Abstract

This article considers the problem of processing and disposing of oil sludge of various origins. Large oil companies are concerned about the problem of incomplete processing of oil sludge. The most hazardous from an environmental point of view include oil sludge formed at all stages of oil production, transportation and refining. In recent years, oil-producing enterprises have introduced various technological solutions aimed at waste management into production, but there is no single method for processing oil sludge for the purpose of neutralization and disposal. All known oil sludge processing technologies by processing methods can be divided into the following groups: thermal - burning in open barns, furnaces of various types, obtaining bitumen residues; physical - burial in special cemeteries, separation in a centrifugal field, vacuum filtration and filtration under pressure; physical and chemical - the use of specially selected reagents that change the physical and chemical properties, followed by processing on special equipment; and biological - microbiological decomposition in the soil directly in storage, biothermal decomposition. Each of them, while having certain advantages, also has its drawbacks. For over 50 years, microwave heating technology has been used in industry. To present the advantages of this method, one needs to turn to the theory of microwave heating.

Keywords: oil sludge, oil waste, influence of electromagnetic fields, water-in-oil emulsions.

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Oil sludge generated during oil and gas production, transportation of oil and oil products, ground water, soil cover and atmospheric air. The amount of oil sludge is constantly increasing. For example, in the Republic of Bashkortostan, more than 0.5 million tons of oily waste are constantly generated, and only about 30% of them are disposed of, the rest is sent to oil sludge collectors. Storage of oil sludge in the drive leads to complex environmental oil problems and her integrated processing ensures the conservation of natural resources.

Many methods and technologies for dehydration, processing and neutralization are known. Oil sludge. It should be noted that each of them, having certain benefits

It has its drawbacks:

- existing methods of dehydration are long in time, require the use of special means (chemical reagents demulsifiers), energy and material consuming;

- in the thermolysis reactors there is a constant transfer of raw materials due to water cut oil sludge, the formation of coke cake is observed at the bottom and walls of the reaction devices, which impedes heat transfer, cleaning the reactor and unloading the products of processing and disposal;

- currently used methods for the disposal of toxic oil sludge are ineffective and time-consuming.

Tighter requirements environmental safety production has made the solution to the problem of disposal of oil sludge particularly relevant. Currently, the main method of disposal is the disposal of sludge at the place of its accumulation. Liquid components are pre-pumped out of the slurry lakes (technical water, oil residues that are processed into oil products), after which the lake is covered with soil, the surface layer of which is being reclaimed.

If environmentalists have no questions about the surface reclaimed layer, the littered oil sludge in the form of a semi-dry residue poses a threat of soil pollution water, so this technology does not meet modern requirements [1].

One of the main and important technological processes in the oil and oil refining industry at oil treatment plants is the dehydration process oil-water emulsion. The water-in-oil emulsion is formed during production, transportation and oil refining and is a heterogeneous system consisting of small drops water dispersed in oil. The main methods for the destruction of oil emulsions of the type “Water in oil” at present: cold separation (sludge without heating), in-pipe demulsification, centrifugation, filtration, thermochemical effect, electrical impact. All these methods require significant investment in various equipment, intended for dehydration. In some cases, this equipment is very bulky and energy intensive.

To increase the degree of dehydration to 95%, microwave dehydration is proposed, which is one of the promising methods for the destruction of emulsions.

Microwave (microwave) radiation is well absorbed by a number of substances and therefore is widely used to heat them. When microwave heating, heat is released in the entire volume material, which is especially useful for drying materials and heating reactive chemicalmixtures. Since microwave heating does not require heat transfer, it is carried out by converting electromagnetic energy into thermal energy in the entire volume where microwave radiation penetrates, then the rate heating of samples can be increased many times in comparison with traditional methods.

Microwave heating has the following advantages over traditional methods heating:

- heating the entire volume of the sample, and not from the surface;

- selective heating, depending on the material of the sample;

- fast on and off heating;

- high heating rate (several hundred ˚ C / min against characteristic ∼ 10 ˚ C / min for devices);

- uniform distribution of active components in the volume of block carriers; - self-limiting reactions (e.g. drying).

All these advantages allow in some cases to significantly accelerate the chemical and thermal processing of substances and to obtain qualitatively new effects and materials.

The mechanism of dielectric heating of materials by microwave energy is based on the phenomenon of dielectric polarization - movement within certain limited limits bound electric charges - dipoles. Under the influence of an external variable electromag- of a magnetic field in the material, their vibrational movement and reorientation occurs, as a result which conductivity and bias currents occur.

The combination of both phenomena and provides heating the material. In 1986, Wolf N.O. patented a method for dehydrating water-oil emulsions when exposed to microwave radiation [2, 3].

A distinctive feature of electromagnetic treatment from other thermal methods is the occurrence of bulk heat sources in oil sludge. Due to dielectric losses in the medium, the energy of electromagnetic waves is converted into thermal energy, resulting in temperature increase, decrease in fluid viscosity. Studying the effects of electromagnetic

fields on oil media are devoted to the theoretical and experimental work of F.L. Sayakhova, V.S. Khakimova, N.Sh. Imasheva, R. M Bashirova, G.M. Panchenkova, L.K. Tsabek A.G. Martynen Co., V.P. Tronova, Kovaleva L. A, G.G. Stresty, L. Homer, Jr. Spenser, R.N. Snow, J.E. Bridges et al. [2, 4–12].

The company ”Imperial Petroleum Recovery Corp.” (USA, Stafford) has developed a microwave system for the processing of difficult to destroy stable emulsion oil sludge.

Emulsion oil sludge enters the unit at a temperature of 26–65 ˚ C, is exposed microwave treatment to create differences in surface tension and phase viscosity,as a result, subsequent separation of the emulsion into phases is accelerated by centrifugation and upholding. After separation, the oil phase is sent for further processing, water phase - to treatment facilities. The degree of oil recovery at this unit is about 98%. Increased plant productivity achieved by parallel placement several models. Such industrial plants are already operating at Exxon’s refineries Mobil ”(USA, California).

In OJSC Tantalum (Saratov) in 1994–2000 designed and manufactured microwave plants where spent oil sludge disposal tests were carried out from drilling fluids and

other waste drilling oil and gas wells, the destruction of water oil emulsions. Using microwave heating toxic waste components immobilized in cement matrices and stored in the annulus of the well, drilling waste is disposed of in the form of a cheap cement slurry.

Microwave heating has significant advantages over traditional methods, so the design and creation of microwave processing of oil-water emulsions is an urgent scientific and technical task.

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